KAJIMA

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The World's Largest-Scale Marine Civil Engineering Project:

The Trans-Tokyo Bay Highway

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The World's Largest-Scale Marine Civil Engineering Project: The Trans-Tokyo Bay Highway

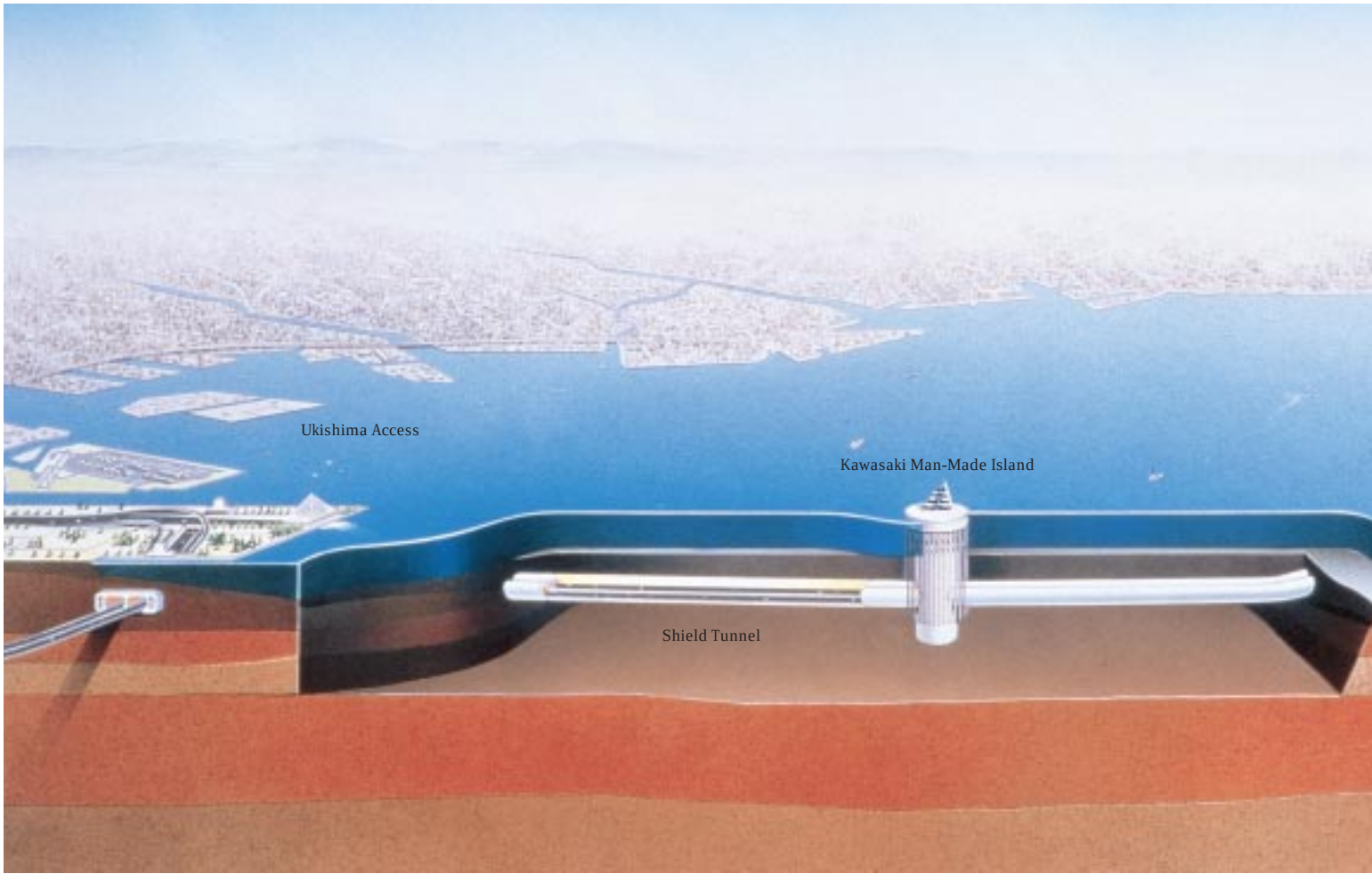
Overview of the Trans-Tokyo Bay Highway

The Trans-Tokyo Bay Highway, also known as the Tokyo Wan Aqua-line, is an approximately 15km highway linking Kawasaki City in Kanagawa Prefecture on the west side of Tokyo Bay with Kisarazu City in Chiba Prefecture on the east side of the bay. Construction of the highway is currently proceeding, and plans call for its completion on December 18, 1997. The Tokyo Wan Aqua-line will link the Bayside Route of the Tokyo Expressway with the Higashi-Kanto Highway. When it is completed, the length of a trip between the city halls of Kawasaki and Kisarazu will be shortened 70km—from 100km to 30km.

The volume of shipping traffic in Tokyo Bay is extremely high. In view of the need to allow for sufficient shipping lanes and other factors, it was deemed necessary to construct the first approximately 10km segment of the Tokyo Wan Aqua-line extending from Kawasaki within an undersea tunnel.

The remaining approximately 5km to Kisarazu is spanned by a bridge. Since this section of the bay is also traversed by numerous ships, the first 750m section of the bridge is elevated 27m above the water on 12 towers, allowing for the passage of 2,000t-class ships.

The Tokyo Wan Aqua-line encompasses two man-made islands—the Kawasaki Man-Made Island midway along the undersea tunnel and the Kisarazu Man-Made Island (also known as the Umihotaru, the Japanese name of a luminous, approximately 3mm-long



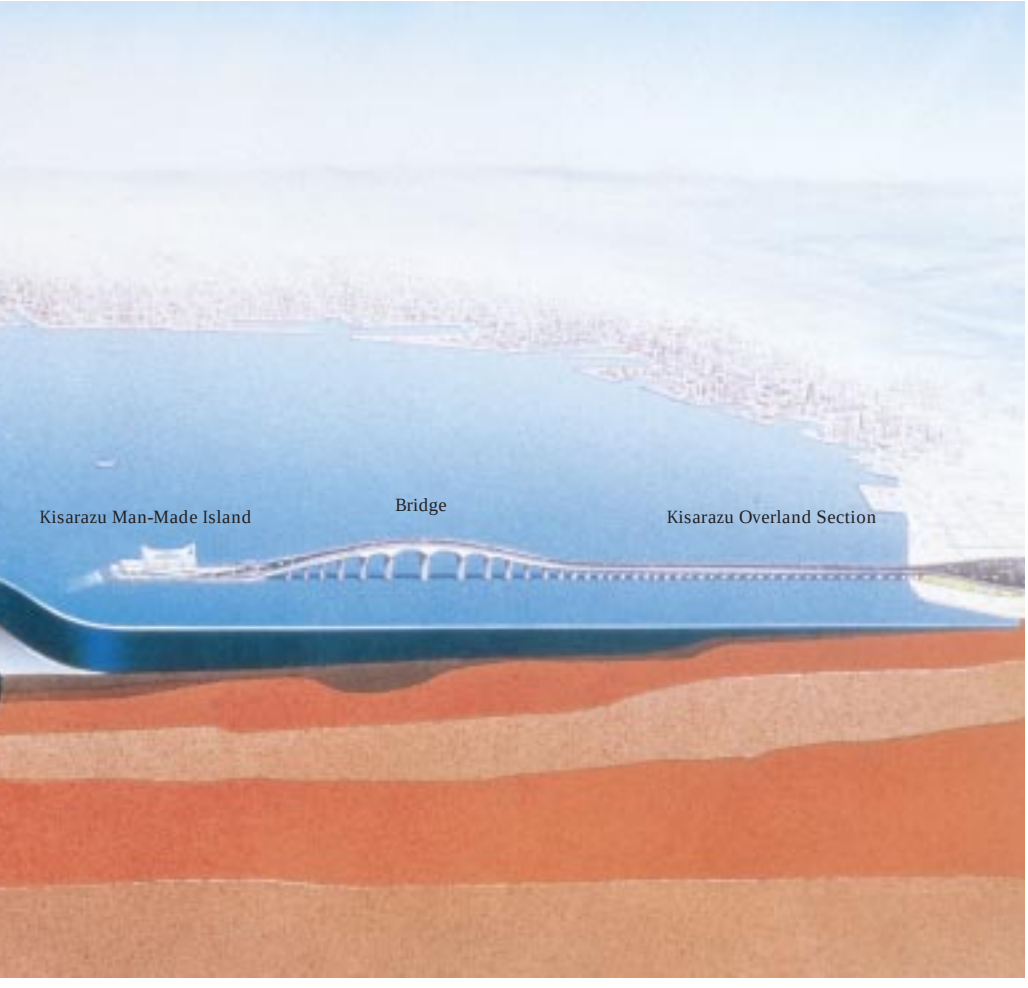
crustacean found locally) where the tunnel joins the bridge. The Kawasaki Man-Made Island, which has a diameter of approximately 200m, incorporates ventilation towers. The above-water portion of the Kisarazu Man-Made Island is 650m long and 100m wide and includes ventilation towers as well as a parking area.

Kajima is responsible for the western portion of the Kawasaki Man-Made Island and the Kawajin North region of the tunnel extending from the island to Kawasaki. Construction of these sections was begun in May 1989.

The Kawasaki Man-Made Island

Kawasaki Man-Made Island, which weighs about 650,000t, has a 98m-wide core. The island is serving as the launching base for shield-driving machines that are boring four tunnels—the largest undersea holes ever created by mankind. The two tunnels stretching from the island to Kawasaki are together referred to as the Kawasaki Tunnel, and the two tunnels extending from the island toward Kisarazu are together referred to as the Central Tunnel. Located 20m beneath the seabed, which is about 28m below the water's surface, these tunnels have 14.14m external diameters, making them the world's largest tunnels created by the shield-tunneling method.

Photos supplied by
TRANS-TOKYO BAY HIGHWAY CORPORATION



The Kawasaki Man-Made Island was created in the following manner.

•First, a firm foundation extending 32m below the soft seabed of Tokyo Bay was created through the use of the SCP and DMM methods. In the SCP method, steel pipes with diameters of approximately 1m were driven into the seabed. Sand was then injected through the pipes into the seabed under pressure to form stable, hard-packed sand columns. The DMM method involved the mixing of a stabilizer material similar to cement with the soft sea bottom material. The two materials underwent a chemical reaction when combined, thus improving the stability of the seabed.

•Next, the circumference of the island was encircled with a donut-like structure, with the inner and outer walls clad in protective steel jackets, and a sand-based composite soil material

was placed in the gap between the two layers, creating an artificial base for the island's construction.

•After the installation of interior guide walls, electromill excavating devices were used to dig spaces for the individual elements of an underground wall, following which a framework of steel reinforcement bars was set up and concrete pouring commenced. Using Kajima's precision management system (a weighted plumb-line system) to great advantage, the excavation for each of the 28 wall elements was performed to a depth of 119m while holding deviation to within 70mm, thus creating the world's largest cylindrical underground continuous wall.

•After completing the concrete pouring for the underground wall and water drainage, the interior guide walls and interior jacket were removed, using a 4,100t barge-mounted crane to lift each 1,100t jacket block.

•More than 10 backhoes of over 30t each were lowered to the bottom of the pit within the jacket. Soil excavated

Precisely Positioning the Huge Steel Jacket of the Kawasaki Man-Made Island

At the location of the Kawasaki Man-Made Island, the ocean is approximately 28m deep, and the top 30m or so of the seabed is soft and unstable. Because of this, considerable work was required to create a solid foundation for the island. Two steel jackets were positioned and anchored with 116 tubular steel piles.

The two layers of the jacket were manufactured in a total of 14 pieces at the Wakamatsu Marine Center of Nippon Steel Corp., in Kyushu. They were transported to the construction site by ship.

Each segment of the outer jacket is 35m wide and 34m tall, or approximately the same height as a nine-story building. Since the jackets are also immensely heavy, weighing more than 2,300t each, lifting them above the water and positioning them was an extremely challenging task.

Kajima's ability to move and precisely position such colossal structures, linking them together in two concentric rings, is eloquent testimony to the sophistication of the Company's construction technologies.

by the backhoes was winched out of the pit using a 1,500t barge-mounted crane with a 45m^3 clam-shell device. Excavation was continued to a depth of approximately 40m below the seabed, which is 75m below the island's surface. Kajima has considerable experience in large-scale excavation for building underground tanks, circular bases for bridge piers, and other structures, but the scale and difficulty of the excavation work for the Kawasaki Man-Made Island was unprecedented. In view of the huge water pressure on the unfinished island's exterior, the Company established a thorough safety system—installing approximately 800 measurement instruments around the circumference and monitoring real-time data provided by the instruments around the clock.

•When the excavation work was completed, prefabricated steel reinforced concrete blocks 27m tall and weighing approximately 2,200t each were lowered inside the island's circumference and more concrete was poured to create an integral unit, including starting-holes for shield-driving machines as well as the internal structure of the ventilation towers.

The Undersea Tunnels

After completing the Kawasaki Man-Made Island, tunnel excavation was begun. The Tokyo Wan Aqua-line is to be housed in two tunnels, one with two eastbound lanes and one with two westbound lanes. The underwater portion of the highway stretches 9.4km from Kawasaki to the Kisarazu Man-Made Island. The tunnels for this portion were created using eight shield-driving machines. Kajima is responsible for constructing the tunnel with eastbound lanes extending 1.8km from Kawasaki to the Kawasaki Man-Made Island, which is being carried out during the period from July 1992 through December 1997.

Applying Myriad Advanced Technologies

When the jackets of the Kawasaki Man-Made Island were in position, two major elements of the island's construction remained—the construction of an underground continuous wall beneath the island and the building of the central portion of the island. Subsequently, two undersea tunnels—one to hold two eastbound lanes of traffic and one to hold two westbound lanes—were extended to the west as well as to the east of the island.

In the space between the two circular steel jackets, a cylindrical continuous wall extending deep underground was built. This wall is an integral part of the island's structure and also serves to prevent water leakage and soil subsidence.

Because of such factors as those related to the durability of machinery, the maximum distance that can be tunneled with a single shield-driving machine based on current technology is approximately 3km. Accordingly, to create longer tunnels, shield-driving machines must tunnel from opposite directions with considerable precision so that the machines can meet at a specified position with less than 50mm deviation. In view of this stringent requirement, a relative position monitoring system for shields, developed with the participation of Kajima, was employed to ensure accurate meeting points for the shield-driving machines that created each of the Tokyo Wan Aqua-line's four tunnels.

With regard to the tunnel that Kajima was responsible for creating, when the two shield-driving machines were 50m from their meeting point, they were slightly out of alignment with each other. As a result of adjustments made over the remaining distance, the machines were ultimately less than 10mm out of alignment when they met.

After freezing the tunnel walls in the vicinity of the meeting point, the shield-driving machines were partially disassembled and removed from the tunnel, which was fundamentally complete at that time.

Aiming to complete the Tokyo Wan Aqua-line in December 1997, the lining of the tunnels with concrete is currently proceeding. When the highway is finished, following nine years of work, vehicles will be able to pass from one side of Tokyo Bay to the other in less than 15 minutes.

Asia

Completion of Shihlin Tower

Chung-Lu (Sino-Kajima) Construction Co., Ltd., completed the 16-story Shihlin Tower in a residential area in the northern part of Taipei. The tower was constructed as the headquarters of Shihlin Electric and Engineering Corp., one of the leading heavy electrical plant builders in Taiwan. It is also intended as a first-class residential building, with plans under way for such amenities as a gymnasium and dining and banking facilities.

Designed by Nikken Sekkei Ltd., the tower has a uniquely shaped top, symbolic of being graced with all the wealth and good fortune coming down from the heavens. The external cladding is polychrome stone from Canada and synthetic aluminum, giving a sophisticated and luminous air to the building. Also, the state-of-the-art amenities, such as a key-box system and a buildingwide OA flooring system, provide tenants with all the security, comfort, and convenience of an intelligent building.

The tower was built on a location that has extremely soft soil conditions. With great technical support and assistance from Kajima and by adopting the appropriate soil improvement methods, Chung-Lu overcame the adverse conditions and completed the project without causing damage to neighboring buildings or ground subsidence in the surrounding area.

United States

Hualalai at Historic Ka'upulehu

Hualalai, at historic Ka'upulehu on the Big Island of Hawaii, is a masterfully planned residential resort community on a 280ha site on the north Kona Coast.

The resort is 11km north of Keahole-Kona International Airport.

The property offers sweeping ocean and mountain views as well as more than two km of white sandy beach. The resort is a mix of single family lots, townhouses, and villas, and the architecture featured throughout captures the true essence of Hawaiian living.

The featured amenities include an 18-hole Jack Nicklaus signature golf course, a 243-room Four Seasons resort consisting of one- and two-story detached bungalow groupings, and a sports club and spa. Hualalai is the only private resort in the state of Hawaii, and its amenities are for the

exclusive use of residential owners and hotel guests.

The owner of the resort is Ka'upulehu Makai Venture, whose managing general partner, Kajima Kona Company, is an affiliate of Kajima Corporation.

Europe

2 The Square: Stockley Park's New Baby

Following a quiet five-year period, during which speculative office development in Europe was just not viable, construction of the awaited 100,000-sq-ft 3 The Square was progressing smoothly when, last summer, we asked architects Arup Associates to put down on paper their ideas for a second smaller building to occupy the critical gap between Stockley Park's established first phase and the emerging new building. Our intention was to situate the smaller building, to be known as 2 The Square, at the "gateway" of Stockley's second phase of offices, bringing the total area to some 414,000 sq ft. The scale and configuration of the structure required particularly careful consideration because of its impact upon the street scene beyond.

By this time, 3 The Square's "building within a building" concept, where the office wings are dramatically separated from a glass external shell by naturally ventilated atrium-like conservatories, had been well received, and a blue-chip IT organisation had entered negotiations for a tenancy, having initially been attracted by the environmental and energy-saving benefits. It seemed obvious to us that the concept should be repeated with 2 The Square, but how were we to conceive of a striking building for this prominent but awkwardly shaped site without it either compromising or being compromised by its towering neighbour?

After much brainstorming, the architects and master planners came up with a novel two-storey structure within a triangular burnished glass envelope surmounted by a shallow pitched roof. Occupying the front of the site, with its entrance facing the main estate road, the tapering 30,000-sq-ft building invites the eye to travel onwards and upwards to view 3 The Square while shielding it from the generous visitors' car park.

Keeping in mind the criteria of corporate tenants and investors, both of the floor plates consist of three rectangular wings radiating out from the central core, the intervening naturally ventilated conservatories being enclosed at their "open" ends by the glass envelope. A deep underfloor air-conditioning* plenum and double-glazed sliding sash windows in the timber-clad inner walls have been designed to allow maximum flexibility for partitioning and office layout.

Detailed planning permission for 2 The Square was confirmed in April, coinciding with the completion of 3 The Square, and excavation for the foundations started in June, soon after its predecessor had been successfully let and sold. A North American computer telecommunications company has already agreed to terms to lease this latest building, which will be completed next January.

**The natural ventilation provided via the conservatories enables the use of the VAV system to be entirely at the tenant's discretion.*

KAJIMA Creations

International Division of Kajima Corporation Receives ISO 9002

Kajima is proud to announce that in July 1997, its International Division received the ISO 9002 certificate from Lloyd's Register Quality Assurance Ltd. for the quality management system applied to civil engineering and building projects under direct control of the division.

The Fifth Biennial Kajima Sculpture Contest

This year the Kajima Sculpture Contest is being held for the fifth time. This contest on the theme of "Sculpture, Architecture and Space" investigates the creation of a new type of space in which the interplay between sculpture and architecture gives birth to a greater entity. Together with sculptors, Kajima Corporation would like to offer cities and people spaces that are filled with the captivating energy and feeling of aliveness that can only be created by sculpture and architecture.

This year, we hope to again receive many inspired entries that fully explore the intimate relationship between sculpture and architecture.

Dates of Exhibition: Saturday, March 7, through Friday, March 20, 1998
Venue: Atrium of the Kajima KI Building
Cooperation: The Kajima Foundation for the Arts and Ilya Corporation

Engineers of the Century Exhibition

On June 25, 1995, the Engineers of the Century Exhibition, or, "L'art de l'ingénieur," opened at the Centre Georges Pompidou in Paris, attracting many visitors worldwide.

Kajima's participation in this exhibition includes displaying scale models and photographs of Nagano Olympic Memorial Arena, the Izumo Dome, the Akita Sky Dome, and more.

The exhibition will be held until September 29, 1997, following which all the materials that Kajima displayed will be transferred to London for public viewing at the Kajima Europe B.V. (London) office from the beginning of October.

The "Can Do" Philosophy of Kajima UK Engineering Ltd. Helps Win the Company the Project of the Year Award

Kajima's nomination resulted from its work on the Nippon Electric Glass "hot" project in Cardiff, an advanced production facility representing part of a £200 million phased investment to manufacture screens for both television and computer monitors for domestic and overseas markets. In this project, time was critical, and design and construction were geared accordingly.

One incident illustrates the company's "can do" philosophy. In order to achieve a milestone deadline, it was necessary to strip down and remove overnight an 8m-high scaffold platform covering 1,600 sq m. The scaffolding company could not commit themselves to the required 8 a.m. deadline, claiming the task would take a week, but Kajima organized extra men to remove materials, leaving the scaffolders to concentrate on dismantling.

Managers joined in to work through the night and before 8 a.m. were sweeping the floor clean in time for the handover at the deadline. This method of encouraging staff to challenge the norm without compromising safety standards was named "bullet track"—outstripping even "fast track" methods. It has now become an established Kajima option for clients wishing to accelerate construction programmes.

Rooftop Greening Method Using Super-Light Recycled Materials

By employing its method using light, man-made bedding soil, Kajima aims to increase the amount of greenery in urban areas. The Company's technique enables the development of a wide variety of greenery, including lawns, shrubs and trees, and vegetable gardens on rooftops as well as other areas that have been difficult to develop due to weight limitations. Kajima has also established the Eco-Healing Garden at the Nishichofu Complex in Tokyo—a demonstration garden that makes use of recycled waste materials and facilitates stress-relief through the pursuit of simple gardening activities.

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